Joint Iterative Decoding and Authentication (JIDA)

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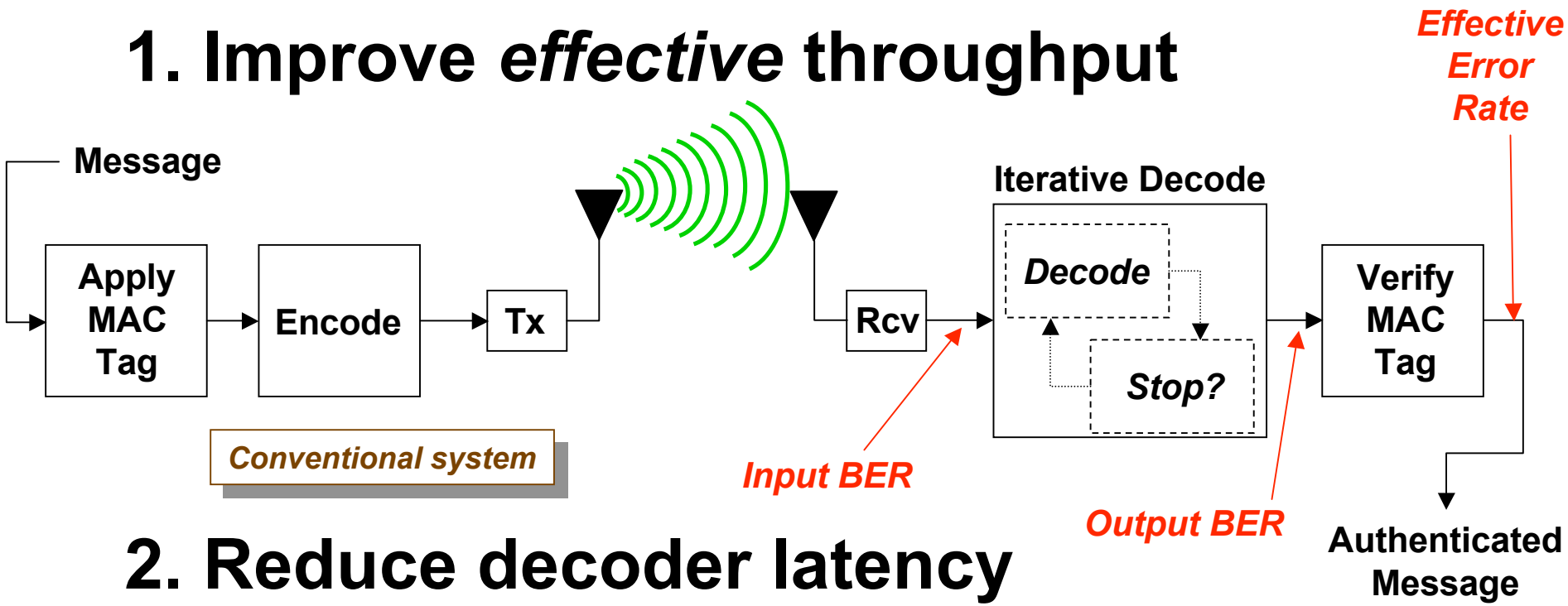
JIDA Objectives

1. Improve *effective* throughput



2. Reduce decoder latency

– Reduce number of decoder iterations by having the authentication module declare packet “authentic” or “correct” packet

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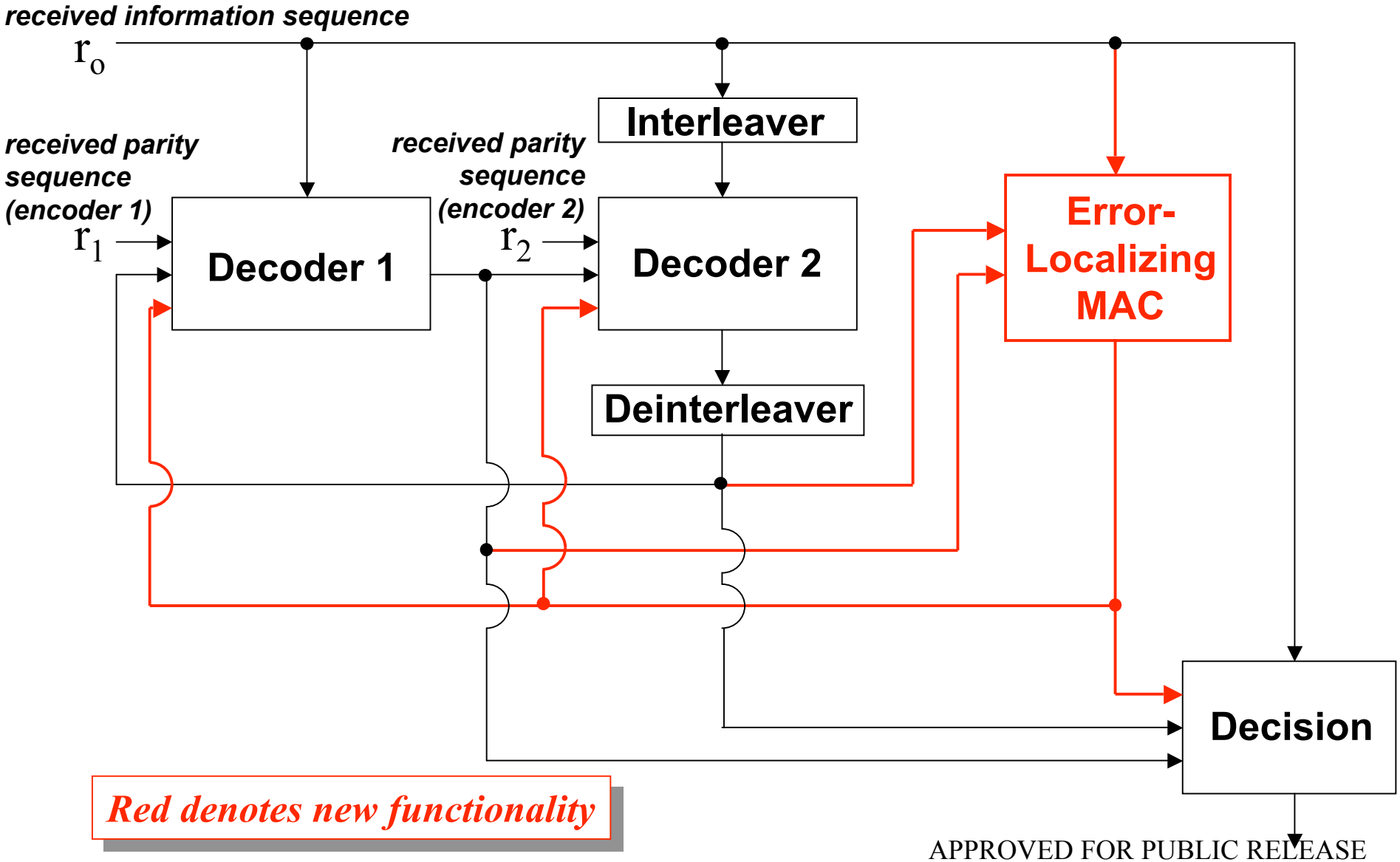
High-Level Approach



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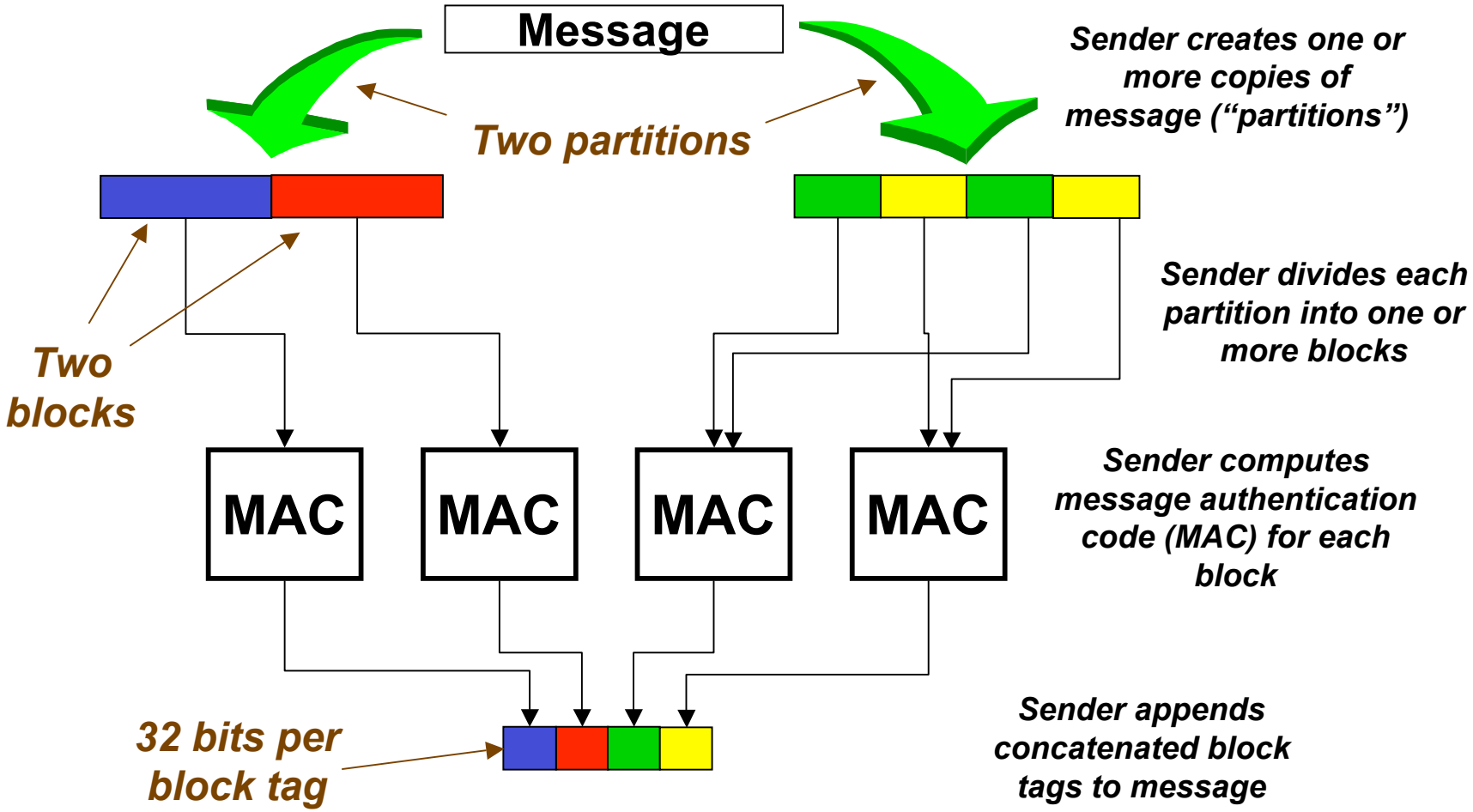
Noise-Tolerant MAC (NTMAC)

- Invented by Dr. Charles Boncelet



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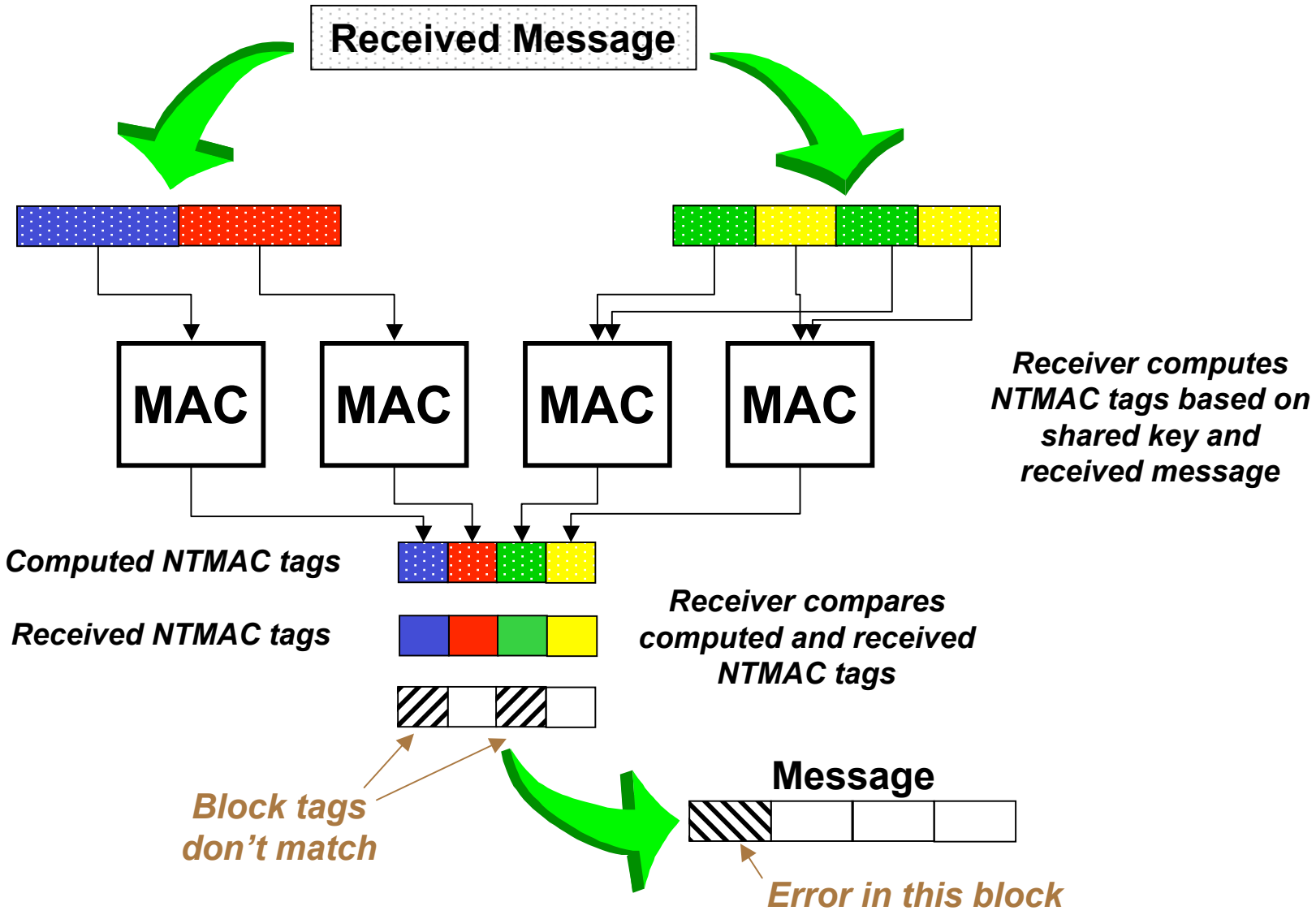
NTMAC Receive Processing



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7/8/4 NTMAC

- Tradeoff single-bit forgery security for error localization
  - 7 partitions, 8 blocks/partition, 4-bit block tags → 224-bit NTMAC authentication tag
  - 32-bit BCH parity check over the NTMAC tag (n=255, k=223, t=4 errors)
  - Probability of a *single-bit* forgery is 2^{-28} per attempt
    - security increases for multiple-bit forgery attempts
- Authentication module returns one of four "flags":
  - "**Authentic**" - the input data/tag pair is authentic
  - "**Authentic when corrected**" - the input data/tag pair is authentic when corrected as denoted
  - "**Estimate provided**" - can not correct the input data/tag pair to authentic result, but an estimate of the log-likelihood ratio of each bit is provided
  - "**Too many errors**" - cannot distinguish correct and error bits
- NTMAC/CE "Hybrid" Termination Criteria
  1. Total Iterations = 30, or
  2. NTMAC returns AUTHENTIC, or
  3. NTMAC returns AUTHENTIC_WHEN_CORRECTED, or
  4. NTMAC returns TOO_MANY_ERRORS ***and*** CE recommends termination

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Monte Carlo Simulation

- Two parallel concatenated rate _ constituent convolutional coders (generating polynomial 7,5) produce net rate 1/3 (unpunctured) or rate _ (punctured) turbo code
- 16384-bit S-random interleaver with S=52
- Linear additive white Gaussian (AWGN) channel
- Compare Two Termination Criteria

1. **Cross-Entropy (CE)**
   - Calculates the approximate cross-entropy between the distributions at the end of successive iterations and terminates decoding of a data frame when the value falls below a user specified value
   - 16384 bits of data per frame (no checksum bits)
   - Terminate after six iterations even if CE threshold not met
2. **7/8/4 NTMAC/CE "Hybrid"**
   - 16128 bits of data plus 256 total tag/checksum bits per frame

– Errors occur in both data and tag/checksum portions

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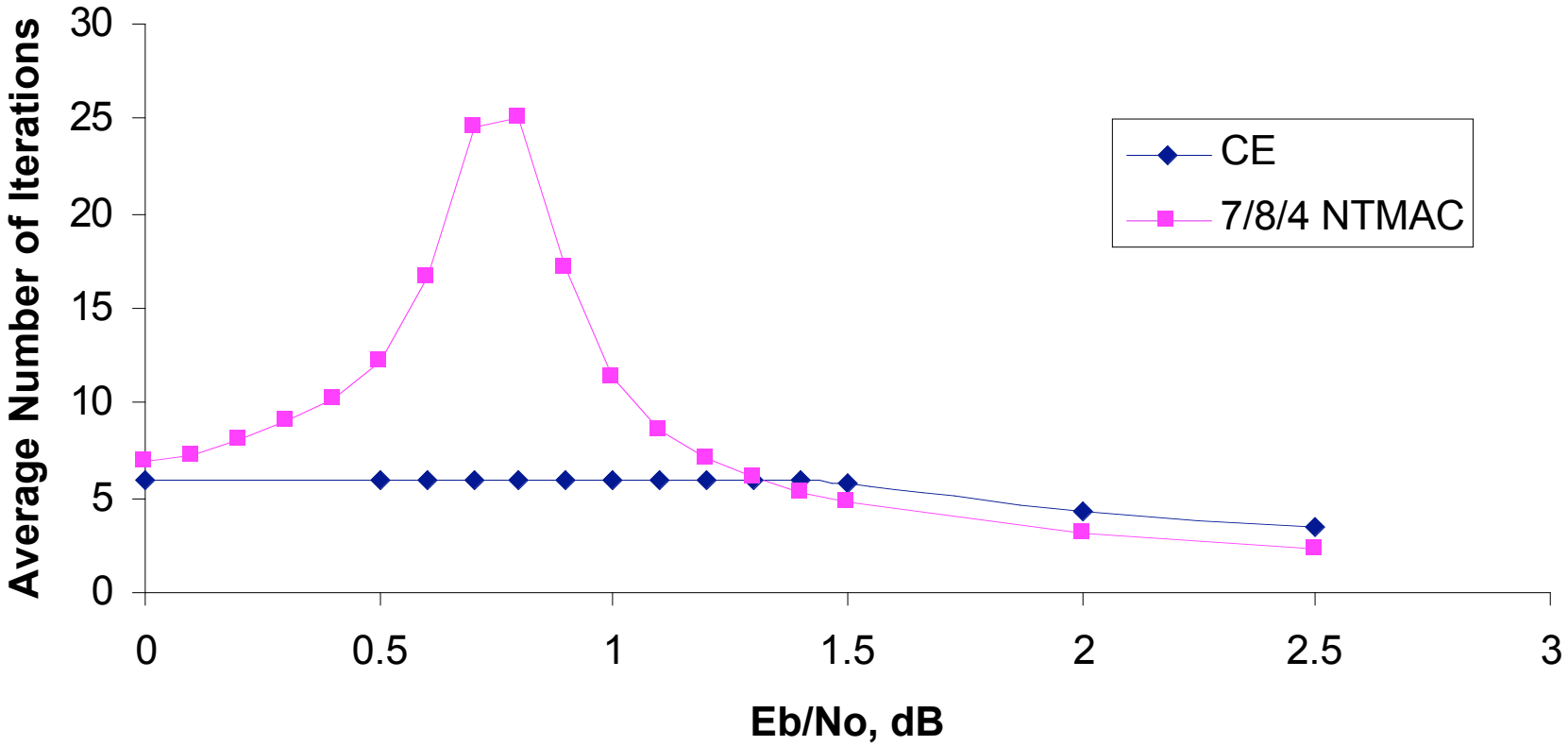
Average Iterations – 16384-bit Frames



"Hybrid" termination method significantly increases average iterations per frame for low E_b/N_o

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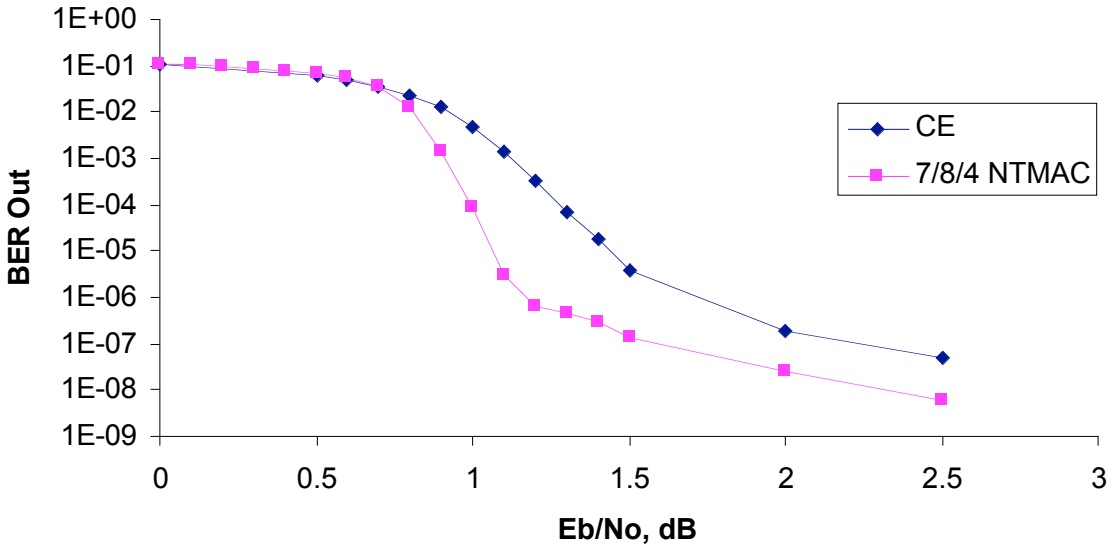
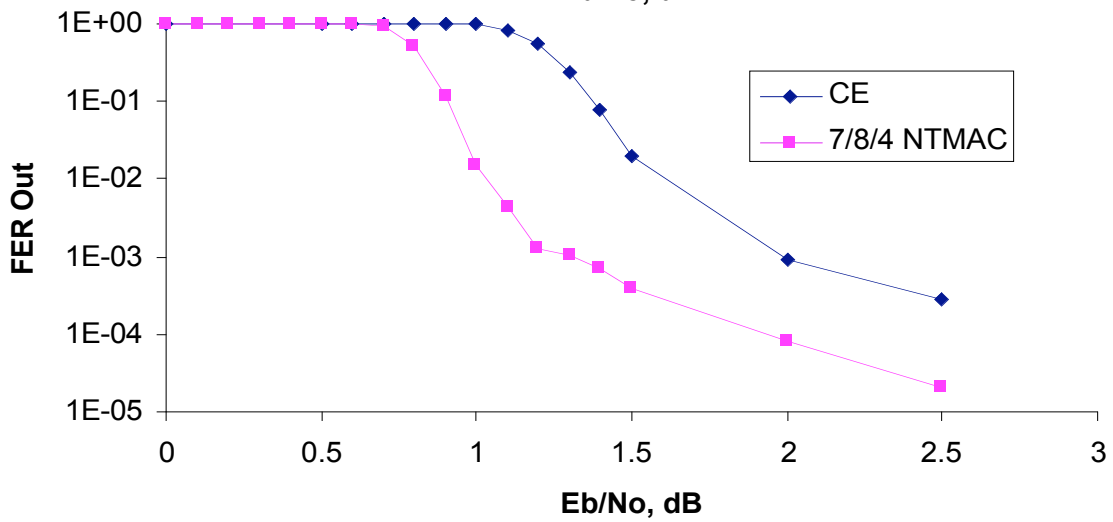
Bit and Frame Error Rates

16384-bit Frames





7/8/4 NTMAC significantly improves output bit error rate

7/8/4 NTMAC significantly improves output frame error rate

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